

**REMARKS**

In reference to Fig. 5, amended claim 9 is directed to a wiring substrate 101 comprising a core substrate 2 including an insulating substrate 25, a through hole 21 provided through the insulating substrate 25, a substantially cylindrical through hole conductor 22 formed on an inner circumference of the through hole 21, and a filling material 23 filling a hollow portion of the through hole conductor. The wiring substrate also comprises a cover-shaped conductor layer 24 provided on at least one principal face of the core substrate 2 and in a shape containing an end face of the through hole 21 and having conduction to the through hole conductor 22; a plurality of resin layers 31, 32 provided over the cover-shaped conductor layer 24; a ball pad conductor 4 provided over the resin layers 31, 32 and having a solder ball 5 to be connected with a connection terminal of an external device; and a connection portion 7 including via conductors 71, 72 buried individually in the resin layers 31, 32 for bringing the cover-shaped conductor layer 24 and the ball pad conductor 4 into conduction. The connection portion 7 comprises a conformal via 71 connected to the cover-shaped conductor layer 24 and one or more filled vias 72 connecting the conformal via 71 to the ball pad 4. The conformal via 71 has a hole wall, a metallic material 712 arranged along the hole wall, and a resin material 713 filling the remaining portion of the hole. Furthermore, taking a through direction of the through hole 21 as being a center axis direction, an individual center axes of the via conductor composed of the one or more filled vias 72 and the ball pad conductor 4 are not aligned with the center axis of the through hole 21.

As claimed in claim 13 depending from claim 9, the filling material 23 filling a hollow portion of the through hole conductor 21 comprises a resin.

As claimed in new claim 16, the one or more filled vias 72 each has a center axis 721 spaced by 50  $\mu\text{m}$  or more and 300  $\mu\text{m}$  or less from a center axis 211 of the through hole 21.

As claimed in claim 17, the conformal via 71 is connected to the upper side principal face 241 of the cover-shaped conductor layer 24.

That is, claims 9 and 13 have been amended to clarify the structure of the wiring substrate, and claims 9, 13, 16 and 17 find written description support in reference to Fig. 5, and at page 26, line 20 - page 28, line 14 of the specification.

Claims 1, 2, 4-8, 10-12 and 14-15 have been canceled. Applicants reserve the right to file a continuation application directed to the canceled subject matter. Review and reconsideration are requested.

Claims 1-8, 10-12, 14 and 15 were rejected under 35 U.S.C. § 112, first paragraph. In the Examiner's view, the specification lacks written description for the limitation "the filling material of the through hole has a coefficient of thermal expansion higher than that of the material constituting the filled vias."

In response, the subject limitation is no longer present in the remaining claims, such that the rejection is moot. However, Applicants respectfully disagree with the Examiner's assertion of lack of written description support.

As described at page 4 of the specification, a resin material has a larger coefficient of thermal expansion than that of a metallic material. When a wiring resin substrate 501 is heated,

a filling material 23 (of a resin material) filling the hollow portion of the through hole conductors 22...expand in the thickness direction. As described at page 6, filled vias are filled up with a metallic material. Importantly, the resin material has a smaller coefficient of thermal expansion than that of the metallic material (page 6, lines 21-23 of the specification).

Thus, Applicants respectfully submit that the specification does support the limitation “the filling material of the through hole has a coefficient of thermal expansion higher than that of the material constituting the filled vias” of the canceled claims.

Claims 1, 2, 4-8, 11, 12, 14 and 15 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. 2002/0145197 A1 (Ohta et al) in view of U.S. 2002/0175402 A1 (McCormack et al). The Examiner relied on Ohta et al as disclosing the wiring substrate substantially as claimed. McCormack et al was cited as disclosing the use of epoxy resin as a through hole filling material.

In response, the rejected claims have been canceled.

Claims 9 and 13 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,909,054 to Sakamoto et al in view of McCormack et al. The Examiner considered Sakamoto et al as disclosing the wiring substrate of claim 9 (including conformal vias) substantially as claimed. McCormack et al was cited as disclosing a cover over a through hole in a core substrate.

The reason for rejection was that it would have been obvious to provide a cover layer over the through hole of Sakamoto et al as taught by McCormack et al so as to impart structural rigidity by capping the through hole.

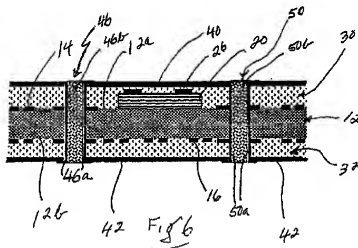
Applicants traverse, and respectfully request the Examiner to reconsider for the following reasons.

As discussed at page 28, lines 3-7 of the specification, the filled via 72 is arranged such that its center axis 721 is spaced by the distance VI<sub>1</sub> from the center axis 211 of the through hole 21 so that it may hardly receive the influence of the expansion/shrinkage of the core substrate 2. More particularly, in the case where an individual center axes of the via conductor composed of the one or more filled vias and the ball pad conductor are aligned with the center axis of the through hole contrary to the limitation of claim 9, push-up from the core substrate is imparted around the plated through hole due to mismatch in the coefficient of thermal expansion between the resin material and the metallic material. Consequently, reliability is deteriorated (especially, due to cracking observed in the heat cycle test as discussed at page 30 of the specification). Particularly, cracking is caused by heat treatment when disposing the solder ball on the ball pad conductor 4. See also the specification bridging pages 2-3, which describes that due to the differing coefficients of thermal expansion of a metal and a resin, in the layer stacked on the core substrate, the force applied by expansion/shrinkage of the core substrate becomes heterogeneous. As a result, cracking occurs in the joint face or the like of a via conductor constituting the connection portion, such that the electrical connection from the through hole conductor to the terminal pad conductor is easily broken.

Turning to the cited prior art, Fig. 12 of Sakamoto et al is said to show the claimed structure, except for the cover-shaped conductor layer containing an end face of the through hole (as pointed out by the Examiner).

However, paragraph [0031] of McCormack et al cited by the Examiner does not disclose a cover-shaped conductor layer containing an end face of a through hole as required by claim 9. Particularly, as shown in Fig. 6 of McCormack et al, a pair of metal-lined vias 46 and 50 (presumably corresponding to the through holes of the invention) are formed by drilling openings through the entire circuit board assembly; more specifically openings passing through metal layers 40 and 42. Thus, there is no cover-shaped conductor layer containing an end face of the metal-lined via (through hole) as required by claim 9.

Thus, the combination of Sakamoto et al and McCormack et al fail to teach or suggest all the limitations of claim 9, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.



AMENDMENT UNDER 37 C.F.R. §1.111  
U.S. Appln. No. 10/787,406

Withdrawal of all rejections and allowance of claims 9, 13, 17 and 18 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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